Issued March 28, 1914.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE NEW MEXICO AGRICULTURAL EXPERIMENT STATION, LUTHER FOSTER, DIRECTOR; REX E. WILLARD, SOIL PHYSICIST.

SOIL SURVEY OF THE MIDDLE RIO GRANDE VALLEY AREA, NEW MEXICO.

BY

J. W. NELSON, L. C. HOLMES, AND E. C. ECKMANN.

MACY H. LAPHAM, INSPECTOR IN CHARGE WESTERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1912.]

WASHINGTON:
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1914.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., August 15, 1913.

SIR: During the field season of 1912 soil-survey work was undertaken in two places in the Rio Grande Valley. The selection of these areas was made after a conference with Luther Foster, Director of the New Mexico Agricultural Experiment Station, which office also cooperated in making the survey. The accompanying manuscript and map cover the Middle Rio Grande Valley area. The important city of Albuquerque lies in this section of the valley.

I have the honor to recommend that the accompanying manuscript and map be published as advance sheets of Field Operations of the Bureau of Soils for 1912, as authorized by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

CONTENTS.

	Page.
Soil Survey of the Middle Rio Grande Valley Area, New Mexico. By J. W. Nelson, L. C. Holmes, and E. C. Eckmann	7
Description of the area	7
Climate	9
Agriculture	11
Soils	19
Tijeras fine sandy loam	24
Anthony sand	25
Anthony gravelly sand	26
Anthony fine sand	28
Anthony fine sandy loam	29
Anthony silty clay loam	29
Gila sand	31
Gila fine sandy loam	33
Gila loam	34
Gila clay loam	36
Gila clay	37
Riverwash	39
Brazito fine sand	39
Irrigation	41
Drainage	44
Alkali	46
Summary	49

ILLUSTRATIONS.

FIGURE.

	Page.
Fig. 1. Sketch map showing areas surveyed in New Mexico	7

MAP.

Soil map, Middle Rio Grande Valley sheet, New Mexico.

SOIL SURVEY OF THE MIDDLE RIO GRANDE VALLEY AREA, NEW MEXICO.

By J. W. NELSON, L. C. HOLMES, and E. C. ECKMAN.

DESCRIPTION OF THE AREA.

The Middle Rio Grande Valley area is located near the center of the State of New Mexico. It embraces that part of the Rio Grande Valley extending from the Indian pueblo of San Felipe, a short distance below White Rock Canyon on the north, southwestward through Sandoval, Bernalillo, and Valencia Counties and ending about 3 miles south of Lajoya, in Socorro County. The area is 83 miles long, has an extreme width of about 5½ miles, and contains 274 square miles, or 175,360 acres. The base map for the entire area was constructed by plane-table traverse in the field, no suitable base being available.

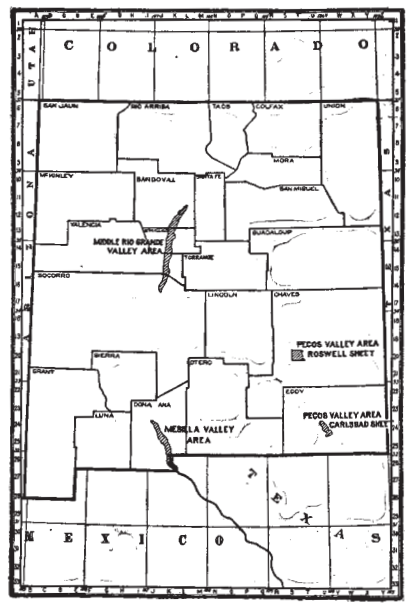

FIG. 1.—Sketch map showing areas surveyed in New Mexico.

The survey covers principally the alluvial valley of the Rio Grande, but includes narrow marginal areas of the adjoining mesa slopes, some of which are capable of agricultural development.

Rather abrupt bluffs or slopes more or less broken and steep usually mark the boundaries of the survey. These form the margins of elevated upland plains of gently to moderately sloping surface, dotted here and there by volcanic cones of moderate to small extent with attending local sheet lava flows reaching up both sides of the valley. The upland plain east of Albuquerque is known as the Sandia Mesa and that west of the city as the Albuquerque Mesa. The Sandia and Manzano Mountains, about 6 to 8 miles distant, constitute conspicuous landmarks upon the east.

The Rio Grande is the principal stream of the area and is the only permanent river traversing the valley. The valley is nearly level from east to west, but has the same gradient southward as the river. From Bernalillo southward to Lajoya, a distance of about 65 miles, the fall averages 5½ feet to the mile. The Jemez and Rio Puerco are contributing, intermittent streams from the west, the former entering the valley near the northern end and the latter near the southern extremity of the area. Besides these, occasional small arroyos enter the valley from both sides and serve to carry off the surplus surface water from the adjoining uplands. The smooth surface of the valley floor is occasionally marked by local areas of hummocky sand dunes and by high banks along irrigation canals and ditches formed by throwing out the sediments which accumulate rapidly from the silty water of the Rio Grande, which is the source of irrigation water.

The first Spanish explorers, entering the valley early in the sixteenth century, found it settled by Pueblo Indians, living in villages, cultivating the fields by irrigation from the river, and following such established customs as to indicate a long occupancy.

The Spaniards were followed by homeseekers, mainly of Mexican nationality. The valley is now thickly settled, and, outside of the immediate vicinity of Albuquerque and one or two of the larger towns, the population consists mainly of Mexicans. Spanish is the prevailing spoken language. The Indian villages of San Felipe, Ranchito, Sandia, and Isleta are located in the valley. American farmers, attracted by the climate and soils, are beginning to realize the possibilities of this region, and the number of American settlers is steadily increasing.

Only a part of the area has been covered by the usual United States Land Office survey, the remainder comprising old Mexican grants. Owing to the fact that the boundaries of the area do not coincide with those of the civil divisions, it is impossible to give accurate statistics of population. A large proportion of the residents of all of the towns except Albuquerque are actively engaged in farming. The rural population usually avoid the low-lying wet lands, and make their homes on the higher lying portions of the valley and along the base of the mesa slopes. The farms are usually very small, and only about one-third of the area is under cultivation. Agriculture is still in a primitive condition.

Albuquerque, the metropolis of the State, with a population of 11,020, is located near the center of the area, on the main line of the Santa Fe Railway. It is connected with El Paso on the south by a branch line of the Santa Fe, and serves as a distributing point

for many outlying districts. The Santa Fe Railway shops, the American Lumber Company, the State university, and many small schools are located at Albuquerque. Other towns in the area, in order of importance, are Belen, Bernalillo, Los Lunas, Isleta, Lajoya, Griegos, Atrisco, Padillas, Sandia, Algodones, Angostura, Peralta, Chavez, Sabinal, San Francisco, Tome, Alameda, and San Felipe, together with a number of smaller villages. Bernalillo is the county seat of Sandoval County, Albuquerque of Bernalillo County, and Los Lunas of Valencia County. Belen is the second most important town in the area. Its location marks the place where the Belen cut-off of the Santa Fe Railway crosses the line extending from Albuquerque to El Paso. Most of the heavy freight and much of the transcontinental fruit shipments pass through this point. It has a large roundhouse and an ice plant for refrigeration purposes.

Besides the public schools, there are a number of industrial mission schools in the area which provide elementary training. Daily mail service and telephone lines extend throughout the area, and no part is more than 3½ miles from a railroad. Good transportation is available for all agricultural products.

Electric power is supplied along the valley for the pumping of irrigation water. Modern farm machinery is in use on only a few farms. Labor is plentiful, but more or less unskilled.

The roads throughout the area are crooked and poorly kept, excepting those through areas of the Anthony fine sandy loam and silty clay loam, which are usually good and seldom need repair.

Agriculture is the dominant industry of the valley proper. Grazing and mining are important pursuits on the adjoining plains and mountains.

CLIMATE.

The climate of the Middle Rio Grande Valley is distinctly arid. There is an average of more than 200 days of sunshine each year. The summer days are warm, though, owing to the low humidity, the heat is not particularly oppressive, and the nights are cool. In the winter the weather is uncomfortably cold only during short periods. The snowfall is light and seldom remains on the ground for any considerable length of time. Outdoor work, except during occasional periods of a few days in the winter, can be carried on throughout the year without inconvenience. Owing to the low humidity, the temperature is subject to more or less abrupt changes. The elevation is about 4,950 feet above sea level. The winds are prevailingly from the west and southwest, although occasionally from the south and east. High winds, carrying a large amount of sand

and dust, are common during the spring months. They augment evaporation, robbing the soil of moisture, and are injurious to tender crops on the sandy soils. The dry winds and arid climate cause an evaporation of 4 to 5 feet annually from a free-water surface. This emphasizes the necessity for frequent cultivation of the soils of the area with a view to the conservation of soil moisture. The winds are nearly always strong enough to operate windmills, which are used to some extent for pumping water for cattle and for household purposes.

The annual rainfall averages 7.51 inches, nearly 50 per cent of which occurs during June, July, and August. The remainder is equally distributed through the other nine months.

The dates of the earliest killing frosts reported in the fall and of the latest reported in the spring, together with the average dates of the last in the spring and earliest in the fall, are shown in the following table compiled from the records of several stations in the region:

Dates of killing frosts.

Station.	First killing frost in fall.		Last killing frost in spring.	
	Earliest date recorded.	Average date.	Latest date recorded.	Average date.
Albuquerque, N. Mex.	Sept. 17	Oct. 19	May 15	Apr. 18
Mesilla Park, N. Mex.	Oct. 10	Oct. 24	May 22	Apr. 17
Phoenix, Ariz.	Nov. 9	Dec. 3	Mar. 31	Feb. 23
Montrose, Colo.	Sept. 8	Sept. 29	May 28	May 10

The climatic conditions of the area are favorable to hardy and late-blooming varieties of fruits, but the early-blooming fruits, such as apricots, peaches, and Japanese and American varieties of plums frequently require careful protection from frost by smudging to prevent loss of crops. The mesa slopes are more favorable to the growing of early-blooming fruits and sensitive truck crops than the valley floor, on account of the better air and soil drainage, the temperature over the mesa slopes being from 1 to 5 degrees higher during cold nights than in the valley.

The table following gives the normal monthly, seasonal, and annual temperature and precipitation at Albuquerque.

Normal monthly, seasonal, and annual temperature and precipitation at Albuquerque, Bernalillo County, N. Mex.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	34.4	69	3	0.40	0.84	2.93	1.8
January	33.8	70	−4	0.40	0.32	1.00	2.0
February	39.3	78	−10	0.24	Tr.	Tr.	1.7
Winter	35.8			1.04	1.16	3.93	5.5
March	47.2	89	12	0.21	Tr.	Tr.	0.7
April	55.7	89	13	0.53	.00	4.20	Tr.
May	64.7	95	30	0.39	0.23	.00	0.0
Spring	55.9			1.13	0.23	4.20	0.7
June	73.4	104	37	0.76	Tr.	1.37	0.0
July	77.1	104	44	1.16	1.20	0.22	0.0
August	75.3	99	45	1.30	0.70	0.72	0.0
Summer	75.3			3.22	1.90	2.31	0.0
September	67.8	97	30	0.88	0.55	0.59	0.0
October	56.6	85	24	0.73	Tr.	.00	0.4
November	43.3	76	7	0.51	1.10	4.70	0.6
Fall	55.9			2.12	1.65	5.29	1.0
Year	55.7	104	−10	7.51	4.94	15.73	7.2

AGRICULTURE.

Stock raising and mixed farming constituted the chief interests of the Middle Rio Grande region until recent years. Upon the completion of the Santa Fe Railway through the valley in 1879 the extensive system of farming and ranching previously followed began to give way to more intensive practices, with a greater diversification of crops. Since that time the growth of population and of agriculture has progressed steadily, many Americans being attracted to the valley by its agricultural resources and favorable climate.

Apples, pears, peaches, quinces, apricots, plums, and grapes are grown in considerable quantities in the area, but fruit production on a commercial basis is not at present successful.

Apple growing is receiving considerable attention. There are a few fair-sized orchards in the area, but most of the fruit is grown on scattered trees along farm boundaries, fences, and in the back yards. The fruit is generally of inferior quality, on account of lack of care and lack of information regarding the selection of varieties suitable

to the soils and climate of the area. Reliable information on this point, however, is now available, and future plantings should be more successful.

The Ben Davis, Gano, Jonathan, Black Arkansas, Winesap, Missouri Pippin, Rome Beauty, and Mammoth Black Twig are the standard varieties of apples, and, in order named, are believed to be the best suited varieties to the soils and climate of this region. Among the varieties of crab apples, the Martha, Transparent, and Whitney are well adapted to this locality.

Well-drained loam, clay loam, and clay of the Gila series, where the surface material is underlain by a silt loam, loam, or heavy fine sandy loam at a depth of about a foot, and the Anthony silty clay loam, where free from alkali, are the soils best adapted to apples in this area. In order to obtain the best results, the soils which are free from seams or strata of sand more than 4 inches thick should be selected. Old river channels and poorly drained soils subject to the accumulation of alkali should be avoided.

The basin, check, and border methods of irrigation are in general use in the area, although the furrow system is preferable to any of these, as it keeps the water away from the trunks of the trees and prevents bunching of the roots in local zones and allows a more equal distribution of the moisture over the surface. From observations under field conditions it appears that from five to seven irrigations of 3 to 5 inches each for each crop will give the best results in apple growing. The amount and time of applying the water will depend upon the size of the trees and the stage of the fruit development. Young trees require less water at each irrigation, but more frequent applications than older trees. Enough should be added each time, however, to encourage deep rooting. The bearing trees in the valley are greatly benefited by a moderate application of water at the time of maturing the crop to enable the fruit to ripen and color properly, as well as to enable the trees to store up reserve energy for the following year.

Cover crops, preferably legumes in this area, should be sown in the orchard each year early enough to form a good sod before winter sets in. The cover should be plowed down early in the spring to improve the soil granulation and add humus. Hairy vetch or Canada field peas are best for this purpose.

Every effort should be made to put the soil in the best possible physical condition by the time the trees come into bearing. One plowing of the orchard to a moderate depth is advisable each year, and clean culture in bearing orchards should be practiced from early spring until late in summer or until the fall cover crop is planted.

The general custom of the valley has been to plant apple trees so close that after 10 or 12 years they fill the entire space.

It has been found from experience that the cost of an acre at the time of full bearing, valuing land with water right at $125, and including labor, pruning and spraying, interest, and depreciation, varies from $275 to $350.

Intertilled crops, such as corn, cantaloupes, tomatoes, and other hoed crops, can be grown among the trees, practically paying for the care of the orchard until in bearing. The life of an orchard in this region should be from 30 to 50 years, depending upon the soil and management. The Missouri Pippin, Jonathan, and Winesap varieties do not live as long as the others recommended for the area. The apples now produced are insufficient for home consumption and prices are good.

For pears the most suitable soils are the clay, clay loam, loam, and fine sandy loam of the Gila series, as well as the Anthony silty clay loam and fine sandy loam, in the order named.

Like the apple, the pear blooms late enough in spring to make the crop reasonably sure. Smudging, however, is sometimes necessary to eliminate danger from late frosts.

The land selected should be free from excessive accumulations of alkali, with a water table at least 3½ to 4 feet below the surface. The subsoils should be heavier than a sand to insure long life and regular yields. Pear trees spread less widely than apple trees and may be set closer together. The cultural methods recommended for apples apply to pears also. Many pear trees of the old Mission variety planted over a century ago are now growing in the valley. These have attained an immense size.

The section of the area best adapted to pear culture, in view of the existing high water table, is less than one-fourth mile wide. extending along both sides of the valley where the mesa slopes and valley soils blend. The climate and soils of the area are favorable to pear culture and, in view of the demand for this fruit, pear raising should prove a profitable industry. The trees are practically free from pests.

The sandy types of the Anthony and Gila series are well adapted to cherry culture. While several varieties of sweet cherries do fairly well, the greatest returns may be expected from the sour varieties, such as the Early Richmond and Montmorency. These bear regularly and are heavy producers. The Montmorency is perhaps the most profitable variety, because the fruit can remain on the trees for nearly a month after ripening without deterioration. Sour cherries suffer but little from pests in this area. They begin bearing at 2 to 3 years after planting. The fruit is excellent for canning and finds a ready market at a good price.

European varieties of plums are well adapted to the Gila loam, clay loam, and heavy phases of the fine sandy loam, and to the Anthony silty clay loam and fine sandy loam where well drained and free from alkali. The Japanese and American varieties should be planted with caution in this area, as they bloom early and are likely to be injured by spring frosts.

Apricots thrive on well-drained, alkali-free areas of the Gila fine sandy loam, loam, and light phases of the clay loam, as well as on the fine sand, silty clay loam, and fine sandy loam of the Anthony series.

The trees grow to large size, and are very long lived. They bloom so early, however, that the production of this fruit on a large scale is unprofitable under natural conditions. With protection from frost by smudging it may be found profitable.

Scattering peach trees are found over the entire valley, but the commercial production of peaches has received but little attention, largely because of the frequent occurrence of late spring freezes, which appear to be the controlling factor in peach production in this area. Alexander, Haynes Surprise, Mamie Ross, Elberta, Crothers, Columbia, and Salway varieties, named in order of ripening, are best adapted to the fine sandy loam, and loam of the Gila series and to the Brazito fine sand. The silty clay loam, fine sandy loam, and fine sand of the Anthony series, where well drained and free from alkali, also give good results. The subsoils of the Anthony series are very well suited to a deep root development of the peach trees, but great care should be exercised in selecting suitable soils in the valley flood plain.

The soils of the Gila series selected for peach culture should be deep and uniform, if possible to 3 or 4 feet, and the underlying material should be heavier than a sand and lighter than a clay for long-lived, uniform, productive orchards.

With an adequate water supply the Anthony soils should prove best suited to this crop on account of their greater uniformity of texture, lower alkali content, diminished danger from a high water table, and location in sections whose temperature during freezing weather ranges from 1 to 5 degrees higher than that over the valley soils. Even with better air drainage, provision should be made to smudge the orchards systematically during the blooming period. The shipping season for any one variety in the valley is about 15 days. For this reason about three or four good varieties should be selected which ripen consecutively, so that the period of harvest may be prolonged. Enough of each variety, however, should be grown to ship in carload lots when eastern markets are the destination. Red and yellow varieties are preferable, because of market demands.

The humus content of the Gila soils, and especially that of the Anthony and Brazito soils, should receive careful attention before planting peaches. In this valley from 24 to 30 inches of water are necessary for the growing season on the Gila series, and a few inches more on the Anthony soils. A good irrigation just before the fruit begins to ripen will greatly increase the size and quality of the fruit. It is important to remember that the very latest ripening varieties are the latest bloomers. The mid-season and early fall varieties are the earliest to blossom, and the early-maturing varieties are medium to late in blooming. Truck crops may be grown among the trees until they come into bearing, but no crops should be grown which might in any way interfere with a vigorous and healthy growth of the trees. As the peach begins bearing at about 3 years, the cost of starting orchards is somewhat less than in the case of apples. The altitude here is about the limit for commercial peach culture. It is comparable with that of the Uncompahgre Valley, Colo.

Quince culture should prove profitable on the loam, clay loam, and fine sandy loam of the Gila series. Many scattered trees are now found in the area. These produce well, although the culture of this fruit has received but little systematic attention. The treatment suggested for apple culture holds good for quinces, but the trees may be planted considerably closer. For commercial culture such leading varieties as the Rea, Orange, Champion, and Meech should be grown.

Bush and bramble fruits are well suited to the fine sandy loam, loam, and light phases of the clay loam of the Gila series and to the fine sandy loam, silty clay loam, fine sand, and heavy phases of the gravelly sand of the Anthony series. They should at least be grown for home consumption.

Neither Irish nor sweet potatoes thrive in the area, owing to unfavorable climatic conditions.

Grape culture is carried on to some extent, and there is a large number of small vineyards in the area. Many varieties have been tried with varying success. The Muscat, Mission, Black Cornichon, and Black Fererra have proved to be among the varieties best suited to these soils. The loams, fine sandy loams, light phases of the clay loams, and the fine sands of the area, where underlain by subsoils heavier than a sand and lighter than a clay, and where well drained and free from alkali, have proved best adapted to grapes. The vines seem to develop so slowly on the heavy types that they often fail to mature and harden well before cold weather sets in. The fruit is also late in maturing on the heavy types and does not color well. The Anthony silty clay loam and fine sandy loam should prove very well suited to grape culture when improved with humus and irri-

gated. The vines are set about 8 feet apart. Very little or no trellising is done. Yields are satisfactory in favorable years, but considerable injury frequently results from lack of proper care and from freezing. Climatic conditions seen to be rather unfavorable to the production of grapes on a commercial scale, but they can be profitably grown for local markets.

Some watermelons and cantaloupes are grown, but the production of these crops is restricted by the more favorable location of competing regions to the north and east with respect to the large markets. These fruits fill an important place, however, among the crops of this region and find a ready local market.

Good yields of onions of excellent quality are produced on the loam, fine sandy loam, and light phases of the clay loam of the Gila series. The Anthony silty clay loam, fine sandy loam, and fine sand are also well adapted to this crop. Onion growing is receiving considerable attention among the intensive farmers of the area, and with proper care is proving very profitable. With systematic effort onion growing should become one of the leading and most profitable agricultural crops of the valley. The Gigantic, Gibraltar, and Brown Australian are very desirable varieties well suited to local soil conditions. Other varieties are also grown, generally with good results.

Considerable chile is grown for home use, but little attention is given to its commercial production. Green chile is used for canning and red or ripe chile for drying. The crop responds to the same treatment and thrives on the same soils as tomatoes. Yields are greatly increased by planting from cold frames. Green chile where well cared for yields from 4,000 to 15,000 pounds per acre. Chile Colorado and Chile Negro are the varieties best suited to this soil and climate. With an available canning factory, chile growing should prove a profitable addition to other intensive crops now grown.

Tomatoes for home use have been grown successfully over the entire valley in past years. With factories for canning, this crop should develop into one of importance. The fine sandy loam and clay loam of the Gila series and the silty clay loam, fine sandy loam, fine sand, and gravelly sand of the Anthony series, in the order named, are best adapted to tomatoes. The light soils produce early crops, but the yields are not quite so large as on the heavier types. Owing to the hot summer days common to this region tomatoes are inclined to mature rapidly and the vines die quickly. To overcome this, medium to early fall varieties should be grown, or two or three varieties which fruit in order.

When grown on the heavy soils the fruit is late, and in this locality the crop is often injured by early fall frosts. Yields of 8 to 10 tons per acre have been secured on small areas, and the cost of produc-

tion ranges from $20 to $35 an acre. There is a great demand throughout the Southwest for fresh and canned tomatoes at good prices.

The soils best suited to asparagus are the Gila loam, clay loam. and fine sandy loam. The crop does moderately well on the lighter sands and fine sands, but the life of the plant is not so long. Where blanched asparagus is grown the soils should be free from gravel. The crop is not extensively grown, but with proper care heavy yields are obtained.

The plants begin to produce at 2 or 3 years after planting and thrive for 10 to 15 years in this valley. With the heavy yields possible, the moderate to low cost of production, and canning factories and markets to handle the product, this industry should prove successful.

Sweet corn does very well on the fine sandy loam, loam, and light phases of the clay loam of the Gila series, and good yields are possible where attention is given the crop.

The Mexican and other varieties of beans produce good yields on the fine sandy loam, loam, and sand of the Gila series and upon suitable bodies of the Brazito fine sand. The crop is easily grown and gives excellent returns.

Cabbage yields well and finds a ready market in the valley at good prices. For an early variety the Early Wakefield and the Hollander and Copenhagen for late varieties do best. The loam, clay loam, and heavy phases of the fine sandy loam of the Gila series, and the silty clay loam, fine sand, and fine sandy loam of the Anthony series, respectively, are best adapted to this crop. The early varieties should be planted on the lighter soils and the late varieties on the heavy types.

Other truck crops, such as peas, carrots, turnips, beets, radishes, celery, rhubarb, pumpkins, parsnips, lettuce, spinach, and squash, do very well on the fine sandy loam and loam of the Gila series and the fine sandy loam, fine sand, silty clay loam, and gravelly sand of the Anthony series. Such crops are in good demand, and excellent returns are secured by farmers using up-to-date methods in their production.

Alfalfa is the staple crop of the valley. Nearly half the tilled land of the area is devoted to this crop. Its superiority for stock feed became known at an early date, and its popularity has steadily increased. It thrives on a wide range of soils, but is best suited to the loam, fine sandy loam, and clay loam of the Gila series, and the silty clay loam and fine sandy loam of the Anthony series. It will grow on the other soils where they are well prepared, irrigated, free from

alkali, and have a low water table. The greatest acreage is on the Gila loam and clay loam.

A remarkable feature in the growing of alfalfa in this area is its ability to thrive and produce well for 6 to 10 years where the water table is from 24 to 36 inches below the surface. In many places the crop suffers from lack of moisture where the water table is only 36 to 48 inches below the surface. The fact that this crop does so well on shallow soils is probably due to the slight fluctuation of the water table and the ability of the crop to develop a lateral root system.

The average production for the valley is about 3 tons per acre. The best soils produce somewhat heavier yields, and the average is kept down by the lighter yields from the less favorable types. Yields could be greatly increased by securing more uniform stands, by cultivating the fields, and by irrigating more regularly. The preparation of the seed bed for alfalfa should receive more attention, and the land should be so leveled that irrigation water will be evenly distributed over the field.

Soils with heavy surface accumulations of alkali should be avoided. Most of the alfalfa is baled and stored until time of marketing. The average cost of production varies from $12 to $16 an acre. The average cost of producing a ton of alfalfa, baled and delivered at the railway station, is from $4.50 to $5. Baled alfalfa sells for $8 to $15 a ton, the price averaging between $9 and $10. The cost of leveling and preparing land in the valley varies from $15 to $50 an acre. Where very uneven and hummocky the cost of such operations will exceed the market value of the land.

In irrigating each crop an average of about 2 applications of 3 to 4 inches of water is necessary. Somewhat more water is needed upon the light, leachy soils than on soils which have a heavy substratum lying several feet below the surface. The alfalfa produced in the valley has fine stems and cures to a rich green color. Little attention has been given to seed production, but where water supply can be controlled seed of good quality is obtained.

The lowest and wettest lands along the river are usually subject to overflow, and these with low, wet areas elsewhere in the valley produce large quantities of " vega," or native hay. This is usually of poor quality and yields are very light.

Sugar beets of high quality are grown in small quantities in the area for stock feed. They thrive on the loam, clay loam, and fine sandy loam of the Gila series and on the silty clay loam and fine sandy loam of the Anthony series.

Wheat, oats, and corn are grown quite extensively over the area and moderate to good yields are obtained. Oats produced in the area weigh from 36 to 42 pounds per bushel.

Corn is mainly of the flint variety, and under the methods now practiced produces ordinarily 10 to 20 bushels per acre. Heavier yields should be secured with proper cultivation. Wheat yields range from 15 to 35 bushels per acre, and from 25 to 40 bushels of oats are produced.

Wheat and oats do best on the loam, clay loam, clay, and fine sandy loam of the Gila series, and the silty clay loam and fine sandy loam of the Anthony series. These crops are not very profitable in the area, but they fill an important place in the rotations. Some corn, milo, and sorghum are grown as dry-farm crops, but the yields are low and uncertain.

Until recently very little attention has been given to crop rotation, but decreased yields are directing more attention to this important feature of farm management.

Beekeeping is an item of considerable importance upon many farms. The climate of the region, together with the large acreage of alfalfa and great quantities of sweet clover, sunflowers, fruit, etc., afford a varied and rich bee pasturage.

The poultry industry, hog raising, and dairying offer great inducements in the area, as the products from these sources are at present insufficient even for local needs.

SOILS.

The soils of the area are classed in three distinct groups, according to their topographic position—those representing the material of the uneroded mesas or upland desert plains, those occupying the mesa slopes along the valley margin, and those of the valley floor.

Each group is represented by one or more soil series, and under each soil series one or more soil types have been recognized. The soil type is the unit in mapping, and the extent, location, and average texture of the soil and subsoil material to the depth of 6 feet of each type is indicated upon the soil map which accompanies this report. The soil series consists of a number of soil types similar in general features of topography, color, character of subsoil or other underlying material, origin, and mode of formation, but differing in texture. A complete soil series thus represents a number of soil types closely associated in these points and ranging in texture of the individual soil types from sand to clay. None of the soil series recognized in this survey are complete, and two of the series are represented by a single soil type only. One of the soil series, the Tijeras, has not been previously recognized in soil-survey work; the others have been recognized in the survey of the Mesilla Valley area, and one of them—the Gila series—elsewhere.

The members of the group of soils occurring upon the uneroded surface of the upland desert plains are represented by only a small area east of Albuquerque, including the State University grounds. This development belongs to the Tijeras series. The surface material of this series consists predominantly of alluvial fan and foot-slope deposits derived from the weathered and eroded material of the Sandia Mountains and deposited by sheet surface water or intermittent streams during brief periods of heavy rains. Beneath the surface mantle the material consists of old river-laid sands, gravels, and finer sediments, deposited by the Rio Grande during an earlier geological period, and constituting most of the material of the upland plains adjoining the Rio Grande Valley in central and southern New Mexico. In this area the surface has been so modified by later alluvial agencies and covered by more recent deposits derived from the adjacent mountains as to have largely obscured the original surface of the plains. The material of the Tijeras series, therefore, is recognized as predominantly formed by alluvial fan and foot-slope deposits resting upon the earlier stratified river-laid material. The extent to which the material from these two sources enters into the formation of the soil is indefinite, but as the Sandia Mountains are approached the alluvial fan and outwash material becomes more important.

The surface is of gently sloping character and is separated from the lower lying soils of the mesa slopes and of the valley bottoms by a distinct bluff or terrace. The parent material has been derived from a variety of rocks in which granitic material predominates. The soils are of red or reddish-brown color and are underlain by pinkish-gray to gray subsoils of highly calcareous or marly character, which usually extend to the depth of 6 feet or more. This calcareous material occurs extensively in the plains throughout the central and southern portions of the State, being found extensively east of the Mesilla Valley, 200 miles farther south. When dry the calcareous substrata assume a partially cemented structure.[1] In the immediate surface-soil material conspicuous quantities of small angular rock fragments occur. The soil supports only a stunted growth of desert shrubs. Underground water is reported to be found in moderate quantities upon the plain at a depth of 150 to 250 feet.

The soils of the mesa slopes have been identified as members of the Anthony series. They occur along the eroded slopes of the high

[1] For further description of the geological character of this material and of the adjacent deposits of the plains and valley, see "Geology of the Albuquerque Sheet," by C. L. Herrick and W. D. Johnson, Bul. Hadley Laboratory, University of New Mexico, vol. 2, pt. 1, 1900; and Geology of the Environs of Albuquerque, New Mexico, by C. L. Herrick, Bul. of the University of New Mexico, vol. 1, 1899.

plains bordering the valley, and are usually separated from the higher uplands by bluffs or an eroded escarpment. The lower margin is not so distinctly marked as in the Mesilla Valley area. In most places, however, it is fairly distinguishable, though occasionally there is a gradual transition from the mesa soils into the soils of the valley flood plain.

The material forming this group of soils consists predominantly of reworked material of the upland formation which has been assorted to some extent and deposited by surface waters as alluvial and colluvial fan and foot-slope deposits over the slopes below. To this in some localities there has been added a small amount of wind-blown material, removed from the Rio Grande bed during periods of low water. The parent material of this group of soils was derived from a variety of rocks and laid down on the uplands as Quaternary or Tertiary deposits. The soils of the Anthony series are grayish brown or light brown to reddish brown in color, a reddish tint usually being perceptible. The subsoils to a depth of 6 feet or more are generally similar in color and character to the surface material.

The surface includes gentle to moderately steep slopes with a fall toward the valley of 30 to 150 feet to the mile. Drainage is excessive, the soils being mainly light textured and porous. Some alkali occurs in the silty clay loam, and occasionally at the lower margin of the other types of this series, caused by the movement and evaporation of water working through the soil from the uplands to the valley drainage below. The series extends far south of the area, and the soils are quite uniform in composition except where modified by wash from the mountains. This group of soils is still in process of formation.

The series is distinctly arid and supports only a stunted growth of scrubby mesquite and other characteristic desert vegetation. Wells dug on the mesa slope show alternating layers of sand, silt, clay, and gravel. A water-bearing stratum occurs at varying depths, which according to the water level in different wells indicates that the source of supply is largely from the adjoining highlands. Deep wells, however, extend to depths lower than the level of the valley floor, and in such cases the lower water-bearing strata seem to be fed from the valley supply. Five members of the Anthony series were recognized and mapped in the area.

The soils forming the valley floor have with two exceptions been recognized under the Gila series. The material giving rise to the Gila soils consists mainly of sediments brought down from regions to the north by the Rio Grande and deposited over the valley during periods of high water. It is derived from a wide variety of rocks, including sandstones, limestones, and metamorphic altered and ig-

neous rocks, which may or may not contain conspicuous amounts of quartz-bearing minerals.

To this has been added small amounts of alluvial wash and of wind-blown material from the mesa slopes. The slight influence of material of the surrounding formations on the soils is due to the fact that the Jemez and the Rio Puerco are the only two tributary streams of any consequence entering the Rio Grande throughout the entire length of the area. These are intermittent in character and contribute material similar to that carried by the waters of the Rio Grande. This material is carried down mainly during torrential rains in June, July, and August. The two tributary streams enter the Rio Grande almost as soon as they emerge from the western upland plains, and the sediments are so thoroughly mixed with those of the main stream that their identity is entirely lost.

The low average gradient of the river accounts for the deposition of a large part of its heavy load of sediment during flood periods. These consist mainly of fine sand, silt, and clay. The river channel through the area varies in width from one-eighth to 1 mile. The bottom of the channel forms a wide, sandy flat with banks averaging 2 to 2½ feet above the river bed. The stream current shifts its course from one side of the channel to the other at frequent intervals, depending upon the deposition of material within its bed. By diking at various points along the river in the area it has been held to one channel for a considerable period and the flood water made to scour a passage rather than change the channel. Areas normally subject to overflow are shown on the soil map by cross lines. They do not represent the maximum overflow, however, during periods of unusually high water. The old channels are filled with fine sand, silt, and clay and are used for growing crops when dry. The material is usually sufficiently well supplied with mineral plant food, but is frequently low in humus content and responds readily to applications of organic matter. The greatest deposition from the river occurs during flood periods when the water overflows areas covered with grass and brush. This frequently takes place in some parts of the area and the large amounts of fine sand, silt, and clay deposited may change the physical properties of the surface material in certain localities to a sufficient depth to require an entirely different soil classification from that of the former surface material.

Numerous old abandoned river channels occur throughout the valley. Sometimes clay deposits several feet deep occur over limited areas of these channels, but most frequently the coarser material forming the old river beds is covered with only a few inches of heavy soil. The alluvial soils of the valley are thus still in process of formation.

Varying amounts of small gravel occur in places throughout the area. A noticeable tongue of fine gravel occurring in the Gila sand begins west of Albuquerque, across the river, and extends southward nearly to Isleta. This deposit was probably made at a time when the river cut into the mesa northwest of Albuquerque. The gravel on the mesa was removed and laid down as local deposits in the valley below.

Considerable sedimentary material is also deposited each year over the entire irrigated portion of the valley by irrigation water. During the long periods of irrigation these deposits have increased until in places they are several feet deep. The material laid down in this manner amounts to one-eighth to one-fourth inch yearly over irrigated lands.

The soils of the Gila series vary widely in the surface features and in soil profile. Changes in texture of the surface material are constantly taking place owing to the annual overflows, wind action, and irrigation. The slopes of fields in many instances have been materially modified in the vicinity of irrigation canals by deposits from water turned on the land. The subsoils consist of alternating strata varying in texture from gravel and sand to clay, and generally without regular order of succession.

The heavy-textured soils of this series within the area seldom have the pronounced adobe structure so common to the heavy types in the Mesilla Valley area. They check less upon drying and the subsoils are consequently less influenced by sedimentary material filtering into or surface material lodging in the crevices. In many places the subsoil of the Gila series contains thin seams or pockets of a dark-gray to bluish-black mud, indicating the presence of local swampy areas at earlier times.

Five members of the Gila series ranging in texture from sand to clay were identified. They are characterized by grayish-brown to dark-brown soils, usually having a perceptibly reddish tint. The upper subsoils are generally similar in color, texture, and structure to the surface material, and are in turn underlain by a bed of interstratified sedimentary deposits of variable texture. The surface is generally smooth, except for occasional remnants of former stream channels, and gently sloping to level. Drainage is usually poor and extensive areas have a high water table and are subject to periodical overflow. In the immediate vicinity of stream channels there is generally a dense growth of willow, cottonwood, and other trees. The surface of the lighter members is frequently modified to some extent and rendered irregular by winds.

The material mapped as Riverwash is associated with the soils of the Gila series and occurs throughout the area, filling the exposed

beds of the stream channels and covering marginal areas which during flood periods are inundated. This material is of sandy character and is mainly of little agricultural value. In origin and mode of formation it is similar to the material of the Gila series.

In places extensive alluvial deposits occur in the vicinity of the stream channels. The material is unprotected by vegetation and is easily drifted. It has been removed by wind action and deposited over areas of the valley floor, giving rise to a type of wind-laid soil recognized as the Brazito fine sand. This type is the only representative of the Brazito series in the area. It is characterized by a light-gray to grayish-brown soil and subsoil, and is more or less of hummocky and irregular surface.

The several soil types encountered and mapped in the Middle Rio Grande area are described in detail in the following chapters. The following table gives the name and extent of each of these types:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Gila fine sandy loam	46,336	26.4	Anthony silty clay loam	4,160	2.4
Anthony gravelly sand	24,576	14.0	Anthony fine sandy loam	2,944	1.7
Gila loam	24,384	13.9	Gila sand	2,752	1.6
Riverwash	18,688	10.7	Brazito fine sand	2,048	1.2
Gila clay	14,272	8.1	Tijeras fine sandy loam	1,600	.9
Gila clay loam	11,584	6.6			
Anthony fine sand	11,072	6.3	Total	175,360	
Anthony sand	10,944	6.2			

TIJERAS FINE SANDY LOAM.

The Tijeras fine sandy loam consists of a rather loose and friable red to reddish-brown fine sandy loam from 8 to 18 inches deep. The surface inch or so contains a relatively large proportion of fine angular gravel and wind-blown sand, and occasional small areas carry small to medium-sized gravel and cobblestones. The gravel and cobbles, with the small angular feldspathic gravel, increase in extent and depth as the Sandia Mountains to the east are approached.

The subsoil to a depth of about 48 inches is a light pinkish gray to light yellowish gray heavy clay loam with a high lime content. From 48 to 72 inches the material is a yellowish or light-brown to medium-brown fine sandy loam. In dry weather, and wherever exposed by wind action, the underlying marly material has a very light pinkish gray color. The calcareous deposit becomes hard and compact when dry or exposed to the air for any length of time, but when wet it is soft and easily penetrated by roots. This deposit is very extensive over the upland plains on both sides of the river, and in some places

is 20 or more feet in thickness. In places the marly deposits extend from a few inches below the surface to a depth of more than 6 feet.

Little difficulty is encountered in the tillage of this type, but its water-holding capacity and granulation are greatly improved by the incorporation of organic matter.

The Tijeras fine sandy loam comprises only a small area on the upland plain directly east of the city of Albuquerque, including the State University grounds and their environs. It is of nearly level surface, and slopes gently toward the adjacent Rio Grande Valley. The type is well drained, free from alkali, and retentive of moisture.

The soil material probably consists mainly of superficial alluvial and colluvial material distributed over the older material of the upland plains as alluvial fan and footslope deposits from the Sandia Mountains. It is underlain by a deep stratum of river-laid gravels and finer sediments included within the old terrace, or river-laid deposits of the plains. The extent to which material from these two sources has become intermingled in the soil and subsoil of the type is not apparent, but it is likely that material of both the older valley filling and of the more recent overflowed deposits is represented in the soil profile. The calcareous deposits of the subsoil have probably been formed from dissolving limestone pebbles in both the surface and underlying formations.

Owing to the high position of this type, irrigation is impracticable, so that it is not utilized for farming. With an adequate supply of water, however, this would be one of the best agricultural soils in the area. It should be adapted to peaches, apples, pears, plums, cherries, bush and vine fruits, truck, and the general farm crops suitable to the climate of the area.

The following table shows the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of this type:

Mechanical analyses of Tijeras fine sandy loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
500346	Soil	2.5	4.8	5.2	28.3	32.0	11.2	16.1
500347	Subsoil	1.2	2.0	3.0	17.1	19.2	26.5	31.0
500348	Lower subsoil	2.3	1.8	3.0	22.4	29.2	23.7	17.6

ANTHONY SAND.

The Anthony sand in its typical development consists of fine to medium-textured sand of loose, porous structure. The type is moderately uniform to a depth of 6 feet or more, and is pinkish or reddish gray to light reddish brown in color. Small quantities of fine,

waterworn gravel frequently occur over the surface, especially where the type grades into other members of the same series. The coarsest material is usually encountered near the surface, and the underlying material to a depth of 6 feet contains large quantities of fine and very fine sand. Owing to its incoherent nature, the soil is easily tilled. The sand particles are rounded, and consist of feldspar, quartz, limestone, volcanic material, and other minerals.

The type has a sloping surface and is developed as irregular bodies along the mesa slopes on both sides of the Rio Grande Valley. The more extensive tracts are found along the western margin of the valley. It occupies a position similar to that of the Anthony gravelly sand and fine sand and merges insensibly with these and the other types of the series.

The type is leachy and requires frequent irrigation for crop production. It loses moisture rapidly because of its low humus content, coarse texture, and open structure.

The material giving rise to this type originated from the mesa bluffs and upland plains formations, and has been assorted and deposited on the lower lying slopes by surface wash and intermittent streams. The surface material is modified and moved about considerably and in some places heaped into hummocks several feet high by winds.

The type supports a scrubby growth of desert plants, and is of little value except for grazing. It is undeveloped on account of lack of water for irrigation, but if irrigated and supplied with humus it is capable of producing good yields of early truck crops, peaches, and cherries. The surface slope is generally favorable to the distribution of irrigation waters but considerable leveling is sometimes required in removing small surface irregularities. The land is valued at $10 to $25 an acre.

ANTHONY GRAVELLY SAND.

The surface soil of the Anthony gravelly sand consists of a light grayish-brown to pinkish-gray gravelly sand, subject to considerable variation in texture and in many places closely approaching a fine sand. Through water and wind erosion much of the fine material has been removed, leaving the surface covered with coarse sand and fine gravel 2 or 3 inches deep. The subsoil is similar in color to the soil and except that the coarse material is usually less abundant, differs little to a depth of 6 feet. It contains pockets and thin seams of sand and gravel, but the amount is small and irregular. Beds of washes and arroyos passing through the type along the western margin of the valley contain large quantities of coarse sand and small subangular and angular fragments of feldspar, which have been washed down from the foothills of the Sandia Mountains. The soil

is quite uniform in texture, except in places where it has been affected by the surface waters of sudden floods. It is loose and open, and easily tilled except in a few places where inextensive beds of gravel and small cobblestones occur.

The upper and outer margin of this type is marked by eroded bodies of gravel occurring as bluffs on both sides of the valley. These gravel areas extend southward from near Albuquerque almost to El Paso.

The type is developed as disconnected narrow bodies of irregular outline varying in width from one-fourth to 2 miles. It covers much of the slopes of the upland plains, and is the most extensive type of the Anthony series. The surface rises east and west from the valley floor with a gradient of 30 to 150 feet to the mile. The topography is generally uniform, but the surface is dissected in places by small arroyos and is sometimes rendered irregular by small hummocks and slight ridges.

Both surface drainage and under drainage are excessive. Owing to its open structure and low humus content the soil is not retentive of water. No injurious accumulations of alkali occur.

The material giving rise to the type consists of old river sands, silts, clay, and gravel derived from a wide variety of rocks. This material was eroded from the higher lying formations and distributed over the lower slopes by the waters of torrential rains. Some wind-blown material has contributed to the soil, but it consists mainly of alluvial and colluvial fan and footslope deposits from the bluffs and high plains. Feldspar, pumice, limestone, mica, and other minerals are represented in the soil material.

Stunted desert plants constitute the native vegetation. Owing to its high position, practically none of the type has been irrigated. It is undeveloped to agriculture, but with irrigation and the incorporation of organic matter the soil should prove well suited to early truck crops, cherries, peaches, and bush and vine fruits. There is less danger from frosts on this type than over the lower lying soils of the valley floor because of superior air drainage. Field peas, hairy vetch, sweet clover, and soy beans do well, both as green manure and forage crops. Land of this type brings from $10 to $50 an acre.

The following table shows the average results of mechanical analyses of fine-earth samples of the soil of this type:

Mechanical analyses of Anthony gravelly sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
500321, 500339.	Soil.....	4.6	11.7	12.6	30.9	20.4	11.7	8.9

ANTHONY FINE SAND.

The Anthony fine sand to a depth of 6 feet or more consists of a light pinkish gray to light grayish brown fine sand often having a reddish tint and frequently of loamy texture. In places throughout the type fine gravel and medium-sized cobbles occur on the surface and in the subsoil. The surface is frequently wind blown and hummocky and is very sandy to a depth of 2 or 3 inches, but the underlying material always has a high content of fine and very fine sand. The type varies in texture, depending upon the steepness of the slopes and the volume of water which has been instrumental in transporting material from the higher lying lands.

The surface is moderately smooth and slopes gently toward the valley. The soil is open and porous, and is easily tilled except in local gravelly spots. The low humus content and the sharpness of the quartz particles present render the soil rather gritty. The porous nature of the soil and subsoil permits ready underdrainage.

The Anthony fine sand occurs as a number of small to moderately extensive bodies along the edge of the valley. It frequently extends up to the mesa bluff, and is often bordered by the gravelly sand member of the series. The drainage is excessive and no damage from alkali occurs.

The soil consists of assorted material brought from the adjacent mesa bluffs and high plains by surface waters and deposited on the mesa slopes below as alluvial fan, and foot slopes and colluvial material. A small amount of wind-laid material is included with the soil. Irrigation, the addition of humus, and careful rotation and tillage are the controlling factors in the cultivation of this type. It supports a sparse natural growth of rabbit bush, mesquite, cacti, and native grasses. Only a very small part of the type has been utilized for crops, on account of the scarcity of water for irrigation. There are no buildings or improvements on the type and it is used only for grazing.

Good yields of cherries, peaches, alfalfa, and truck crops are possible with irrigation. The soil warms up early in spring and is adapted to early maturing crops. The type is valued at $10 to $50 an acre.

The following table shows results of a mechanical analysis of a sample of soil of this type:

Mechanical analysis of Anthony fine sand.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
500340	Soil	7.5	10.3	6.4	24.2	37.1	8.4	6.1

ANTHONY FINE SANDY LOAM.

The Anthony fine sandy loam consists of a fine sandy loam varying in depth from 36 to 72 inches. The surface soil is light yellowish gray or grayish brown to pinkish gray. It carries a large amount of very fine sand and a moderate amount of silt. The lower lying areas of this type are sometimes underlain by a loamy subsoil at a depth of 36 inches, or this may be replaced by or in turn rest upon a fine sand or sandy loam which continues to a depth of 72 inches.

The topography varies from smooth to occasionally undulating, the surface being sometimes wind blown and marked by small sandy hummocks. The general slope is toward the valley at an inclination of 25 to 60 feet to the mile. In places along the lower boundary this type overlaps the soils of the Gila series, and where this occurs the subsoil becomes similar to the material of that series.

The type is open and friable and is easily tilled. Its structure and moisture-retaining capacity may be improved by the incorporation of organic matter. Alkali in small quantities sometimes occurs along the lower margin of the soil areas, but this is easily removed by drainage and irrigation.

The material giving rise to this type has been brought down during torrential rains from the higher lying mesa and upland plains and deposited over the lower margin of the mesa slopes.

When properly handled this type ranks close to the Anthony silty clay loam in productivity and crop adaptation. Very little of the type is under cultivation, owing to lack of irrigation facilities. However, where water for this purpose is available this soil is capable of producing good yields of fruits, truck, and general farm crops. There are very few homes or improvements on the type. It is utilized mainly for grazing purposes. At present the type is valued at $20 to $60 an acre, depending upon location and improvements.

The following table shows results of mechanical analyses of samples of soil and subsoil of this type:

Mechanical analyses of Anthony fine sandy loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
500337	Soil	0.7	2.1	2.9	23.2	36.3	22.0	12.8
500338	Subsoil	2.1	7.6	8.6	38.3	32.1	6.2	5.1

ANTHONY SILTY CLAY LOAM.

The Anthony silty clay loam consists of a pinkish-gray or grayish-brown silty clay loam from 3 to 6 feet deep. The soil of this type

occurring on the alluvial fan south of Albuquerque where the Tijeras River enters the valley is underlain at a depth of 36 inches by a pinkish-gray silty clay, 12 inches or more in depth and resting upon a stratum of pinkish-gray loam to silty clay loam. In other places, however, the soil section is fairly uniform to a depth of 6 feet or more. One or two smaller tracts north of Albuquerque have a much more reddish color. Occasionally small seams or pockets of gravel or sand occur in the subsoil, but such deposits are of minor importance. From many wells dug on this type it has been found that, except in the areas mentioned, the soil material continues generally uniform to a depth of 30 or more feet.

The soil is moderately friable and is easily cultivated. The structure and productiveness can be improved by applications of stable manure or by growing green crops such as Canada field peas or hairy vetch to be plowed under. Small hummocks of wind-blown sand and silt occur in places over the surface of this type, which when leveled and worked into the soil give it a slightly sandy appearance.

The Anthony silty clay loam is not an extensive type and occurs only as small alluvial fan deposits where intermittent streams enter the valley and as small, irregular bodies along the base of the mesa slopes.

With the exception of occasional small hummocks and small arroyos, the surface is fairly uniform, and very little leveling is necessary to prepare the type for irrigation. If flooding is practiced, however, the land should be carefully leveled. The furrow method of irrigation is advisable on this type.

The type slopes toward the valley at the rate of 30 to 65 feet to the mile, which is ample to provide good drainage. Part of the type carries harmful quantities of alkali. Drainage conditions over the type have improved with the opening of deeper arroyos and underground passageways for run-off water, and alkali conditions may be improved by careful management of the soil and heavy irrigation.

The material forming this type originated from the reworking and assorting of fine sand, silt, and clay from the higher lying mesa soils and from the upland bluffs and plains. This has been laid down over the lower mesa slopes as alluvial fan and footslope deposits. Through this process small quantities of soil are continually being added whenever flood waters from the uplands extend over the valley. The soil particles closely resemble those of the other soils of the Anthony series, but are much finer. Irrigation, good tillage, and the addition of humus are essential in the cultivation of this type.

The native vegetation consists of the characteristic plants of this region. The growth is small, and constant grazing for long periods has kept the humus supply low.

The excellent slope of this type protects the crops grown upon it from late spring and early fall frosts. It is well adapted to apples, pears, European varieties of plums, cherries, quinces, grapes, bush and vine fruits, general farm crops, and truck. Peaches do well, but smudging is necessary where early-blooming fruit is grown. The land should be planted to some other crop for a year or two preceding the setting out of the orchard. The addition of manure or the plowing under of green manure crops, preferably legumes, should accompany the growing of young trees in the orchard to insure their healthy, vigorous growth. Some areas of the type are now being rapidly developed, but most of it is still used for grazing.

Water of excellent quality for irrigation has been obtained from wells varying in depth from 35 to 100 feet and flowing 250 to 800 gallons per minute. These wells are sunk on the mesa slopes and electric power is used for pumping. The cost of water obtained in this manner necessitates the growing of intensive crops and the use of modern methods of farm management.

Land values vary according to location and development, ranging from $30 to $150 an acre.

The following table shows the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of this type:

Mechanical analyses of Anthony silty clay loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
500314	Soil	0.0	0.2	0.2	1.7	10.8	58.7	28.5
500349	Subsoil	.0	.0	.0	.2	1.4	54.8	43.4
500350	Lower subsoil	.0	.1	.2	1.6	21.1	56.6	20.4

GILA SAND.

The Gila sand consists of a grayish-brown to yellowish-gray sand, often showing traces of pink or reddish colors, and varying in depth from 6 to 60 inches. The type has a medium to coarse texture, is somewhat loose in structure, and is easily tilled. The subsoil consists of interstratified or alternating sediments, and varies from a sand to a clay in texture. There is no regular order in the arrangement of strata. In many of the areas the material is somewhat more compact and less leachy than the Brazito fine sand, and in texture and structure portions of the type approach a sandy loam.

The surface is somewhat hummocky and wind blown. Areas carrying fine, rounded gravel occur over portions of the type. A very pronounced body of this kind extends as a narrow strip along

the west side of the Rio Grande from Albuquerque nearly to Isleta. The gravel was deposited by the river at a time when the stream passed through that part of the valley.

The type is developed as comparatively inextensive bodies occurring throughout the area. The surface is moderately level to slightly irregular or hummocky. The greater part of the type is moderately well drained, but accumulations of alkali and a high water table are encountered in slight depressions.

The material is predominantly alluvial in origin, consisting of sediments deposited by the Rio Grande or its tributaries and derived from a wide variety of rocks, including limestone, sandstone, and quartz-bearing and quartz-free metamorphic and igneous rocks. Subsequent to its deposition the surface material has drifted considerably. A small amount of material from the mesa slopes has been blown from the upland soils and mixed with this type in places along the valley margin. The movement of the soil particles by high winds is less noticeable, however, than on the fine sand of the Brazito series. The water table is seldom more than 4 feet and frequently less than 2 feet from the surface.

Scrubby mesquite brush and a stunted growth of grass constitute the principal native vegetation.

There is but little agriculture and few farm buildings on the type. It is low in humus content and in moisture-retaining capacity, and except in the lower lying moist bodies requires rather frequent and copious irrigation. The more hummocky areas often require leveling in preparing the land for irrigation.

Well-drained areas of this type are adapted to early maturing truck crops, peaches, and cherries. Where the heavier subsoils do not occur at too great depth alfalfa does well.

Land of this type sells for $15 to $75 an acre, depending upon location and improvement. Not more than 20 per cent of the type is now under cultivation. Drainage, intelligent irrigation, the incorporation of organic matter in the form of stable or green manure, careful tillage, and crop rotation are important factors for successful crop production on this type.

The following table shows the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Gila sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
500311	Soil	6.9	15.0	16.4	39.8	13.3	4.4	4.2
500312	Subsoil	1.3	9.3	17.4	45.6	17.5	4.3	4.7

GILA FINE SANDY LOAM.

The Gila fine sandy loam is a uniformly pinkish-gray to light-brown fine sand, often showing a reddish cast, and ranging from 6 to 36 inches in depth. The subsoil consists of a variety of stratified sedimentary material. Ordinarily the surface soil is a little darker and has a more distinctly reddish tint than that of the same type as recognized in the soil survey in the Mesilla Valley, and the subsoil is generally much lighter in texture. While the type averages a fine sandy loam in texture, this is subject to considerable variation, and local areas occur in which the material approaches either a fine sand on the one hand or a loam upon the other. In low, flat areas the subsoil is usually a very coarse sand, sometimes alternating with thin seams of clay and quicksand and saturated with water. The soil of higher and better drained areas usually has a heavier average texture than the more recent lower-lying deposits, consisting of varying strata of sand, silt, and clay.

This is the most extensive type in the area and is mainly confined to the low, flat areas of recently deposited material along the present Rio Grande channel or in similar positions in old abandoned stream channels.

The type carries large quantities of fine sand and, in places, a high percentage of silt. In structure it is open and friable. It is free from gravel or other coarse material and may be tilled without difficulty. Much of the low-lying portion of the type has a mantle of clay underlain by lighter material, but the heavy deposit is too shallow materially to affect the texture. The type is moderately low in humus. Parts of it along the base of the mesa slopes have been influenced by wash from the soils of the Anthony series and have a somewhat darker color, due to a higher content of mica. Where irrigated the silt and clay deposited as sediment from the irrigation water gradually render the texture heavier. The type occurs as widely distributed bodies.

The topography is level to gently sloping. Drainage is poor, and most of the type is too low and wet for profitable crop production. Small hummocks of fine sand sometimes occur over the surface. The general character of the surface is favorable for irrigation.

The water table over most of the type is encountered at less than 18 inches. It is seldom lower than 24 inches in the higher areas. Injurious accumulations of alkali are frequently present. The coarse-textured subsoils of the low areas permit the free passage of subsurface water and during flood periods in the river a rise of the ground water is soon noticed in such places.

The low, wet areas are suited only to cottonwood, willow, and native hay, although they furnish considerable pasturage. Much of the type lying along the river is subject to periodical overflow during which it receives large quantities of new sedimentary material. Wherever the surface of the type is undulating alkali appears in the low places. The salts continue to considerable depth wherever the subsoil is of heavy texture.

With a water table 2 feet below the surface the type can produce good yields of truck and shallow-rooted annuals. If the ground water lies at a depth of 3 or more feet alfalfa, oats, truck crops, peaches, apricots, plums, pears, cherries, and grapes can be grown. When well drained and free from alkali, the type is suited to a wide range of crops. Drainage and the incorporation of humus are the greatest needs of the type. Little attention is given to crop rotation and tillage is usually very shallow. Numerous buildings have been erected and considerable improvement made on the better drained sections of the type. The flat, wet areas are unfit for buildings and homes.

About 20 per cent of the type is under cultivation. The land sells for $10 to $200 an acre, depending upon location and improvements.

The following table shows the average results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of this type:

Mechanical analyses of Gila fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
500322, 500343	Soil.....	0.1	0.8	4.2	44.0	26.4	12.8	11.7
500323, 500344	Subsoil.....	.2	1.0	1.4	10.8	17.1	47.9	21.8
500324, 500345	Lower subsoil...	.3	1.6	4.7	30.1	21.9	26.1	15.4

GILA LOAM.

The surface soil of the Gila loam consists of a light-brown to rather dark gray heavy loam often showing a distinct reddish tint and having a somewhat silty character. The clay content is generally high and the structure compact, the material approaching a clay loam in texture, although the heavier areas undoubtedly include some bodies of undifferentiated clay soils of the same series. The subsoil varies from a loose, open sand to a heavy clay, and like the subsoils of the other types of the same series consists of interstratified sediments without uniformity in order of succession. This material may be of uniform texture to a depth of 6 feet or several different strata may be present, varying in thickness from 2 to 20 or more inches. In some places a medium to large amount of very fine sand

and silt is present, giving the soil a very floury appearance. Wherever this type occurs along the base of the mesa slopes it has been more or less influenced by wash from the uplands and is darker in color and contains a more conspicuous quantity of mica.

The type is one of the most extensive in the area. It is easily cultivated, particularly when the organic content is maintained by the use of stable manure or green manuring crops.

The type occurs as nearly level to gently sloping areas of irregular outline throughout the valley. It is perhaps the most important and highly developed type in the area. More than 40 per cent of it is farmed to intensively cultivated crops. The water table over much of the area is from 10 to 20 inches below the surface. In such places large quantities of alkali occur near the surface and the soil is not well suited to crops without drainage.

The alluvial sediments giving rise to this type were derived from a wide variety of rocks, and have been brought down by the Rio Grande from regions to the north and deposited over the valley floor by flood waters and by irrigation. Some areas of this type are now in process of formation, and others are being covered by lighter or heavier sediments, giving rise to other types of the Gila series. The subsoil of this type over the higher parts of the valley is much heavier than over the lower and more recently formed areas. In the latter situations the porosity is such that water will drain away rapidly. By lowering the water table to 3 or 4 feet ordinary irrigation will remove the alkali present.

Wherever the ground water is 26 to 32 inches below the surface, shallow-rooted annual and biennial crops can be grown successfully. Where fruits are to be grown the water table should be lowered to at least 42 to 60 inches—the deeper the better—and the subsoil should be of medium to heavy texture. Such conditions will insure a long-lived orchard with greater regularity in bearing. Apples, pears, plums, cherries, quinces, and bush and vine fruits, in the order named, are the best adapted and most profitable crops upon this type of soil. Alfalfa and peas, beans, chile, and other truck also produce heavily where care is given them.

This type has the widest range in crop adaptation of any of the Gila series, and with careful management, including the incorporation of organic matter, a carefully devised crop rotation and good tillage, good crop yields are possible. Land is valued at $50 to $200 an acre, depending upon location and improvements.

The following table shows the average results of mechanical analyses of samples of the soil and subsoil and a single analysis of the lower subsoil of this type.

Mechanical analyses of Gila loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
500327, 500341	Soil	0.2	1.1	1.9	13.8	23.1	39.6	20.3
500328, 500342	Subsoil	.2	1.7	2.5	22.3	25.1	26.9	21.1
500329	Lower subsoil	3.0	14.4	15.0	43.9	16.9	4.3	2.6

GILA CLAY LOAM.

The surface soil of the Gila clay loam consists of a light reddish brown to grayish-brown, compact, heavy clay loam, from 4 to 20 inches deep, and often showing a pinkish tint. In places the type includes some undifferentiated material of clay texture. The subsoil consists of irregularly alternating strata varying in texture from fine sand to clay.

The texture of the surface soil varies considerably, owing to the deposition of silt and clay by irrigation water and overflow. Wherever the type occurs as low, flat bodies along the Rio Grande the surface material is very shallow and is generally underlain by an incoherent, loose sand saturated with water. Such areas are still in process of formation, new deposits being added each year by overflow from the river.

The soil is compact and rather refractory and impervious, but with careful tillage, liberal incorporation of organic matter, and a systematic rotation of crops the structure of the soil may be readily improved. The addition of humus imparts a darker color. Wherever the type is subject to overflow or to the accumulation of surface or seepage water it has a tendency to become compact and puddles easily.

The Gila clay loam is an important type in the area. It occurs as medium to small bodies of irregular outline. It usually occupies slightly higher elevations than the clay of the same series, but in most places is so low that it is seriously affected by a high water table and suffers from injurious amounts of alkali. The surface features present few irregularities, and little leveling is necessary in preparing the land for crops and irrigation.

Much of the type is covered by a moderate to heavy growth of cottonwood, willow, and salt grass. Over most of the areas covered by the type the water table is less than 18 inches below the surface, giving crops in such places a very shallow root zone in which to develop.

The soil forming this type consists of alluvial sediments derived from a variety of rocks. These sediments were brought down from regions to the north and deposited as alluvium over the valley by

flood waters. In places where the flow of such water is kept uniform by brush or other impediments the deposits are not subject to much change to a depth of several feet. However, in less protected places the clay loam deposits of one year may be covered by material of a much lighter or heavier texture the following year, depending upon the volume and velocity of the moving water.

Only a small portion of the type is well drained and suited to the growing of crops. Wherever the water table is 3½ to 4½ feet below the surface the type is well adapted to alfalfa, wheat, oats, corn, peas, apples, quinces, plums, sugar beets, cabbage, bush and vine fruits, and heavy truck. Fruit culture is not advisable on this type, where the water table is encountered at less than 3½ to 4½ feet from the surface, nor where alkali has accumulated. A deep water table is preferable for all crops. The subsoil of this type should be of medium to heavy texture for fruit. Under such conditions the orchard will be long lived, productive, and vigorous. Peas, beans, rhubarb, chile, and asparagus give good results in well-drained areas, but tomatoes mature so late that injury from early fall frosts is likely to reduce the yields. When drained the best phase of this type ranks among the most productive of the soils in the area. The area of this type in the vicinity of Corales is especially well developed. About 40 per cent or less of the type is suitable for tillage under existing conditions. The entire type is favorably situated for irrigation from the river.

Land values range from $10 to $200 an acre. Excellent land with water can be obtained for $100 an acre.

The following table shows the average results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of this type:

Mechanical analyses of Gila clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
500306, 500317	Soil.....	0.0	1.3	2.3	15.5	14.7	35.3	30.9
500307, 500318	Subsoil.....	.3	1.3	4.0	29.8	26.5	17.2	16.2
500308, 500319	Lower subsoil...	.3	4.7	14.6	55.1	17.6	3.7	4.1

GILA CLAY.

The surface soil of the Gila clay consists of a heavy, tenacious, and compact clay, varying in color from dark gray to reddish brown or reddish gray and extending to a depth of 4 inches to 6 feet. As is the case with other members of the series, the subsoil is variable. In the low-lying wet situations it usually consists of an incoherent, saturated sand. In other places the material is quite uniform in tex-

ture to a depth of 6 feet. This is perhaps the most poorly drained type in the area. The most typical bodies of this soil occur in flat areas below the soils of the mesa slopes in old abandoned river channels and in depressed bottom lands adjacent to river channels now occupied. The heavy texture and close, compact structure of the type cause it to puddle badly, especially if plowed when too wet. The granulation of the soil is very weak, owing to its almost constantly saturated condition which can be improved only by drainage, the addition of organic matter, and good tillage. The soil is so compact that percolating waters move slowly, but the high temperature and drying winds cause rapid evaporation which is enhanced by the high capillarity of the close-grained material.

The type occurs as medium to small bodies throughout the area. They are most frequently of elongated form and extend in the general direction of old river channels. The topography is generally smooth and level, and owing to its low position it is frequently overflowed during flood periods, except where diked or remote from the river. The deep deposits are usually the result of many years of accumulation under uniform conditions of overflow. The shallow areas are of more recent age, and where conditions are such as to regulate the flow of the flood waters, additional deposits amounting to one-eighth inch to an inch are made each year. In some instances several inches are laid down over small areas during a single period of high water.

The poor drainage of this type has caused surface accumulations of alkali in many places. The alkali salts occur in large quantities to the depth of the clay deposits.

The Gila clay consists mainly of deposits of silt and clay brought down by the Rio Grande from northern regions and deposited over low-lying areas throughout the valley. Irrigation waters also carry large quantities of this material, which in a few years form a sufficiently deep deposit over the fields essentially to modify or alter previous soil conditions.

A heavy growth of salt grass and water-loving plants resistant to alkali, cottonwood, and willow occur over the type. Low, wet areas are used for the production of vega, or wild hay, and as pasture. The higher and better drained areas produce good yields of wheat, oats, corn, alfalfa, pears, and plums. Where the type is well cared for, alfalfa yields from 3 to 5 tons per acre each year, wheat 15 to 25 bushels, oats 25 to 50 bushels and corn 10 to 20 bushels. Very few buildings are located on the type because of its low, wet, and unsanitary condition. Drainage, proper irrigation, good tillage, and the maintenance of the organic-matter content of the soil are the controlling factors of successful farming on this type. It is

well adapted to dairying and should be used mainly for that purpose.

Land of this type sells for $20 to $150 an acre. The productive value of the low, wet areas of this type under existing conditions is from $3 to $5 an acre annually, but after reclamation the value is many times that amount.

The following table shows the average results of mechanical analyses of samples of the soil and a single analysis of the subsoil of this type:

Mechanical analyses of Gila clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
500310, 500325	Soil	0.2	0.6	0.9	3.2	6.6	39.6	48.9
500326	Subsoil	.3	1.5	3.5	12.3	17.1	31.2	33.9

RIVERWASH.

The entire bed of the Rio Grande within the area has been mapped as Riverwash. Most of the river bed is exposed during the greater part of the year.

The material consists mainly of fine sand, with large quantities of silt and clay. Deposits of river sediments are continually being added. The material is subject to wind drifting when exposed and is usually devoid of vegetation. It is of little importance for farming purposes, although it may be made available for agriculture if protected from overflow. Many old abandoned channels in the valley have been reclaimed and are now used for crops. Quickly maturing hand-cultivated crops are occasionally grown on Riverwash, and under favorable conditions fair yields are obtained.

The type has a generally level to wind-rippled surface, and occurs as extensive white sand flats. Much of the wind-laid material of adjoining soils in the valley has been derived from this source.

A storage system farther up the river to regulate the flow of flood waters would enable farmers to reclaim and utilize extensive areas of this type for farming purposes.

BRAZITO FINE SAND.

The Brazito fine sand consists of a light pinkish gray to light yellowish gray smooth fine sand, which is loose and incoherent and varies in depth from 6 inches to 6 feet. It usually consists almost entirely of sand of the fine and very fine grades, although a few areas of medium to coarse sand, too small to map separately, occur within the type. In the deeper bodies the material is uniform to a depth of 6 feet. The shallow bodies occur in depressions between small dunes

and hummocks, where wind has removed the loose sand to within a few inches of the underlying strata of alluvial sediments. The higher portions of the type are rolling and hummocky and free from alkali. The water table as a rule is deep enough to permit the growing of crops. Large quantities of alkali and a high percentage of silt are present in the depressions and the water table in such places is within a few inches of the surface. The surface of these low bodies is moderately firm and flat.

The type occupies small, irregular areas throughout the valley, marked usually by the occurrence of low, hummocky sand dunes. The most extensive bodies occur north and southwest of Albuquerque and southeast of Isleta, where they encroach upon the adjoining alluvial soils.

This soil consists predominantly of material transported by wind action from the alluvial sands of old river beds or of exposed stream channels. A small part of the soil has been derived from material of the upland plains or mesas. The type includes small bodies over which but little modification by winds has taken place. Such bodies usually occur as slightly depressed or level areas of former stream channels or recent alluvial deposits protected from the winds by native vegetation or otherwise. They are recognized as an alluvial phase of the type and in a more detailed survey would be classed as a distinct alluvial type of the Gila series. They are, however, of but little importance.

Part of the type is barren of vegetation and part supports a scanty growth of brush and grasses. When leveled, irrigated, and supplied with organic matter in the form of stable or green manure the type is well adapted to the production of early cherries, peaches, and truck. Where the substrata of heavier alluvial sediments are not too far below the surface alfalfa, corn, sorghum, beans, peas, and asparagus do well. The soil warms early in the spring and produces very early crops. Irrigation for a few years has a tendency to make the structure heavier by adding deposits of silt and clay. Very little of the type is under cultivation because of the high expense necessary in leveling and preparing the land for irrigation.

The following table shows the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Brazito fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
500315	Soil	0.0	1.9	7.4	56.0	26.4	2.2	6.1
500316	Subsoil	.0	1.0	5.1	48.9	25.4	4.6	15.2

IRRIGATION.

The Middle Rio Grande Valley is one of the oldest irrigated regions in the United States. It is known that irrigation has been practiced continuously for 300 years, and there is evidence in less disturbed sections nearby that the early occupants of the valley used the water of the Rio Grande for crop production long before the discovery of America. The prehistoric races used only those lands which were easily tilled and to which the river water could be easily applied. Following this long period of crude irrigation farming, the valley was settled by Spaniards and Mexicans, who introduced new crops and improved methods of farming and irrigation.

The system of irrigation now in use in the Middle Rio Grande Valley is the community ditch, or "acequia," as it is locally known. These ditches, of which there are about 50 throughout the valley, are typical of the community ditch system in New Mexico. Many of them have been in use, following the same crooked lines, since the advent of the Spaniards. Under this system the landowners of a given district organize for the irrigation of their lands. The water is diverted directly from the river, without any dam in the channel, through a main canal into the district to be watered. The upkeep of the ditch is borne proportionately by the landowners, who contribute money and labor toward the maintenance of the ditch system. Besides the large area of land in the valley watered by the various canal systems, there are many thousands of acres which may be irrigated by pumping from wells furnishing an abundant supply of excellent water at 10 to 40 feet. The use of gravity canals is confined to the valley floor, and no water is diverted from the river to irrigate the fertile mesa slopes adjoining each side of the valley and comprising about 100 square miles within the survey. Some development is now taking place on the mesa slopes, and wells are being sunk to irrigate the land. Good flows of excellent water have been encountered in such places at depths of 45 to 100 feet. Several wells are now supplying water on the mesa slopes, and continuous flows of 250 to 800 gallons per minute have been obtained. The water-bearing strata of both the mesa slopes and valley floor consist of layers of sand and fine gravel. It has been estimated that water can be supplied on the mesa slopes for $4.50 to $5 an acre-foot when the depth of the well does not exceed 100 feet. Electric power is now being supplied at a very reasonable price to operate pumps throughout the valley, and considerable development may be expected in the near future in irrigating from this source.

The Rio Grande is the chief source of water supply for the area, supplemented by the natural rainfall and a small overflow from the high plains. Where drainage is good, alkali does not accumu-

late from the use of the water in the Rio Grande or from the wells. The only danger is in areas having a high water table, where the water is near enough to the surface to cause excessive evaporation. Such a condition will, in a few years, cause an accumulation of injurious amounts of alkali even though the amount of salts carried by the irrigation water is small. The irrigation waters of the valley carry no black alkali because of the large amount of gypsum in solution. Large quantities of mineral plant food are left in the soils annually by the evaporation of irrigation and flood waters.

Little or no attention has been paid to the amounts of irrigation water necessary to give the most efficient returns from crop production in the area. In many instances too much water is added, and at other times too little. From results obtained in the Mesilla Valley, where soil conditions closely resemble those of the Middle Rio Grande Valley, it appears that 26 to 30 inches of water is ample for general farm crops and fruits. A slightly smaller amount would suffice in the area on account of the somewhat less rapid evaporation. For deep-rooted crops the soil should be moistened to a depth of 3 to 4 feet, and for shallow-rooted, quick-maturing plants from 1 to 2½ feet.

Although the supply of water from the river is inadequate, under the wasteful methods now in use, a much greater area could be covered by a more conservative use of the available supply. Excessive evaporation, too frequent and shallow irrigation, excessive flooding, lack of cultivation, uneven surface, poorly constructed and leaky or obstructed canals and ditches are largely responsible for the present waste.

Wherever the soil types are underlain by loose, incoherent subsoils, small amounts of water added frequently will serve the best purpose. Fields poorly prepared and handled will require much more water to mature a crop. Excessive use of water not only increases the cost of production but impairs the physical condition of the soil, increases the danger from a high water table and the accumulation of alkali, and breaks down the soil granulation. Careful experiments should be conducted on each of the main types of soil in the area to learn their water requirements for the various crops grown. In addition it must be remembered that the best results can be had only when the irrigated land is properly prepared before planting.

Porous soils, such as the lighter types of the Anthony series, the Brazito fine sand, and some members of the Gila series, require a large volume of water in the furrows to carry it to the far end of the fields before there is much loss by percolation. As soon as the water reaches all parts of the field the volume of flow should be decreased. The first rush of water over the heavier soils forms a

thin film of mud over the surface, and the water does not sink very rapidly after that. In the case of fine, compact soils, such as the clay and clay loam types, the water should be turned into the furrows and allowed to run slowly to the far end of the fields. The stream should be increased gradually as it approaches the lower end, because in flowing rapidly the water tends to smooth the sides and bottoms of the furrows, thus checking percolation.

The furrow method is very desirable when the fall is sufficient for its use, as it keeps water away from the plants and soaks laterally into the ground without injuring the granulation of the soil, scalding the trunks of the trees, or causing the surface to bake and crack. The farm is not cut up into so many borders, and it does not require so much leveling as the flooding system, and is thus better suited to rough and hilly land. It is adapted to a wider variety of crops and conditions than any other form of irrigation. It permits of the use of small streams and requires less skill and experience in irrigation. There is less danger from overirrigation, less injury to farm machinery, and less expense in leveling, while the yields are usually larger.

With compact soils such as clay loams and clays, where the surface and slopes are generally uniform and the supply of water abundant, flooding between field ditches over long, narrow areas, if the lands are well graded, is the cheapest system of irrigation. It is not so economical in the use of water, however, as the furrow method. The lands and ditches may be straight or on contour lines if the slope is uneven. In this area the ditches should be from 2 to 8 rods apart, depending upon the slope of the land and the amount of water available. The land should be sufficiently level for water to spread from ditch to ditch. If the fields are long, water may be turned in at proper intervals from the side ditches.

For the loose, sandy types, such as most of those in the Rio Grande Valley, where the land has very little fall, the check system of flooding is used to good advantage. One good distributing ditch may serve two rows of checks. The larger checks require more grading. For the greatest efficiency in this area they should be less than an acre in size.

The basin method is a modification of the check system, and is used chiefly for orchards. The checks are made around each tree and extended out as far as the roots go. This system is not used extensively in the area, but it is well adapted to soils where gophers and burrowing animals are present.

Wherever possible cultivation should follow either of the above methods of irrigation as soon as possible in order to check loss of moisture through evaporation.

Shallow irrigation tends to keep the roots confined near the surface. Deep irrigation promotes a more extensive and deeper rooting system; and if thorough cultivation follows, moisture is kept deep in the soil for a long time. Flooding causes the surface to puddle and bake, and much moisture is lost before cultivation can take place. Water should be added to the poorly granulated soils of this area in such manner as to disturb the surface as little as possible. This may be accomplished by deep-furrow irrigation.

When and how to irrigate will depend upon the character of the soil, the season, temperature, and rainfall, as well as the crops to be grown.

Experience in this region indicates that water applied in the late fall or winter is almost as effective as an application in summer. Well-drained lands of the area become dry during the fall, and if the ground is made moist by winter irrigation it freezes and the granulation is improved. Through this practice the blooming period of fruit trees is apparently delayed from a week to 10 days in the spring, which often enables them to escape severe frosts.

DRAINAGE.

During the progress of the soil survey of the Middle Rio Grande Valley special attention was given to the depth of the water table, on account of the poorly drained condition of much of the area. From about 1,500 borings equally distributed over the valley, the water table was encountered at 6 inches to 6 feet from the surface over more than 90 per cent of the valley floor, having an average depth of about 23 inches. The depth to the water table in inches, as ascertained by these borings, is indicated on the accompanying soil map. The average depth of 23 inches is too shallow for the successful growing of most farm crops. Roots of the general farm crops and tree fruits utilize the surface 4 feet of soil for their best development in arid regions, and when confined to less than half that depth, besides having alkali to contend with, they are greatly hampered in supplying plant food. Roots of only a few plants thrive in a water-logged soil and most of these are of little value. Deep-rooted crops on soils with a shallow water table have difficulty in adjusting their root system to the unfavorable soil conditions, and weakened plants and reduced yields result.

Good soil drainage is a very important item of farm management in both humid and arid climates, but it is of greater concern in arid regions because of the accumulations of alkali which are nearly always associated with a high water table. Shallow-rooted annuals and plants with excessive lateral root systems do moderately well on soils with a water table from 20 to 24 inches below the surface,

providing accumulations of alkali are not present in harmful quantities.

The high level of ground water and the heavy surface accumulations of alkali in this area are very unfavorable to oxidation. The activities of bacteria are also checked by retarded air circulation. Fortunately, however, the water table fluctuates very little here, and when plant roots are once established they are seldom disturbed by any rise of the ground water. This enables alfalfa to do well in the valley where the water table is from 24 to 36 inches below the surface.

A study of the root systems of various plants under field conditions over affected areas has led to the conclusion that while the detrimental effects of alkali have not been overrated the relatively injurious effects of the high water table have not been sufficiently appreciated, and many farmers are content to wait for the natural lowering of the ground water. The present alkali content of the soils would not be a serious menace in the area were it not for the high water table, for, although alkali appears in heavy deposits over many places, it is confined to a very shallow zone near the surface, and could easily be leached out by ordinary irrigation if the ground water were lowered. The removal of alkali under existing conditions, however, would only give temporary relief.

The water table of the area is highest from early March until July. During this period the snows in the drainage regions to the north are melting and the volume of water in the river is greatly increased. The porous condition of the subsoils and the freedom with which water passes through them cause a rise of the water table over the lowlands.

About 75 per cent of the entire area is located within the flood plain of the Rio Grande, and practically all of this region would be greatly benefited by drainage. Crop growing in local areas has been discontinued on account of high ground water and injury from alkali, such lands now being used only for the production of wild hay and as pasture. The ground water varies with the rise and fall of water in the river, but the degree of fluctuation is considerably less in the subsoils than in the river. The river is probably the source of nearly all of the ground water, the shallow river bed being the chief cause contributing to the high water table over the valley. The banks of the river channel are seldom more than 2 feet high. At every rise of the river it overflows at some places, and is only kept in check at others by dikes along its banks. The surface in many parts of the valley is lower than the river bed and flood water is kept out only by diking. Additional water is contributed from excessive irrigation and through arroyos and underground pas-

sageways leading from the adjoining high plains. The amount from such sources, however, is relatively small. An increased depth of the water table in any part of the valley is accompanied by a slight ridge, a slope, or sand dunes. The water table varies little from east to west, but has a gradient southward of about 5½ feet to the mile.

In numerous borings very coarse material was encountered a few inches below the surface over most of the low, wet areas. Such coarse deposits are so permeable that water passes through them with little resistance.

The greatest problem in the future agriculture of the Middle Rio Grande Valley is the installation and maintenance of an efficient drainage system. This should be planned to keep the water table at a depth of 4 to 5 feet, sufficient to permit deep root development. No concerted effort to drain the valley has been made, largely because of the absence of legislation providing for the proper organization and regulation of such work. An effective drainage law, however, was enacted by the State legislature in 1912, and reclamation of the wet lands now awaits only the united action of the citizens of the valley in perfecting the necessary organization.

ALKALI.

In the area surveyed most of valley floor and a small part of the lower margin of the mesa slopes are affected by alkali. No separate map was made, but the location of alkali areas are indicated by symbol on the soil map. More than 90 per cent of the alkali is confined to the surface 18 inches of soil. It is only in small areas having heavy subsoils that the salts are encountered in injurious quantities at a depth greater than 18 inches.

General surface appearances of affected areas indicate a very heavy accumulation of the salts. Considerable difficulty is experienced in many parts of the valley in growing crops in badly affected places, not only because of the salts present, but also because of the high water table, which forces root development near the surface within the zone of the greatest alkali accumulation. This unfavorable condition has made much of the area unsuitable for crop growing, and the badly affected localities can only be utilized for the production of vega hay and as pastures.

During high winds large quantities of finely divided alkali salts, which have accumulated at the surface, are blown about in clouds of white dust.

There are no beds or deposits of concentrated alkali salts in the alluvial deposits of the valley or the adjacent plains to which the source of the deposits may be ascribed. Owing to the limited rain-

fall of the region and deficient drainage the mineral salts normally occurring in the soil material, due to the chemical breaking down of the mineral particles of the rocks from which the soils are derived, are not entirely leached from the soils and removed in the country drainage, as is the case under humid conditions. Consequently small amounts of such salts, which are readily soluble in underground and surface waters, remain distributed throughout the soil and subsoil material. Usually the mineral salts occur in small quantities and are so uniformly distributed through the soils and underlying material that their presence is not harmful to plants, but when carried in solution by underground or surface water to lower lying depressions they are collected and deposited near the surface under conditions of deficient drainage or become concentrated in the soil and subsoil through evaporation of the waters in accumulations sufficient to injure crops. In addition to the residual salts of the soils, the waters of the Rio Grande and its tributaries carry in solution small quantities of alkali, particularly during certain periods of the year, and although the water may be good enough for household purposes, it leaves a small amount of salts at or near the surface as it evaporates, so that in a few years apparently good water with heavy evaporation will deposit a sufficient amount of alkali in the surface soil to cause injury to crops. This process of evaporation has been going on for many years in the area, and the present alkali deposits largely represent the residue left from the evaporating waters.

The small accumulations on the mesa slopes have been formed from the evaporation of seepage waters from the uplands in their passage to the valley drainage channels. The accumulations on the steeper slopes do not increase as a result of the upland waters forming deeper passageways into the valley.

The alkali salts move up and down in the soil and subsoil with the water, descending when irrigation water is applied or during rainy periods and being returned to or nearly to the surface in dry weather by the capillary rise and evaporation of the soil moisture. These salts are generally noticeable at the surface in dry weather over affected areas, but in parts of the valley, along its margin where the water table is several feet below the surface, and where the rainfall is light and runs off readily, no irrigation being practiced, the salts frequently concentrate in the subsoil and can not be seen on the surface. Such places can usually be detected, however, by the greasewood or other alkali vegetation occurring over the surface.

The salts contained in the valley soils of the area constitute white alkali, the absence of black alkali being due to the fact that the river water carries gypsum in solution, which corrects any carbonates that may occur. This is not the case, however, with the soils

of the mesa slopes, for, while the sample analyzed shows no carbonates, field observations indicate that the tendency is toward the formation of black alkali. Owing to the small amount of seepage from the upland, however, there is no important accumulation of the more injurious alkali salts on the valley slopes.

Analysis of a composite sample of alkali taken from various places over the valley flood plain.

[Parts per 100,000.]

Constituent.	Quantity.	Constituent.	Quantity.
Ions:		Conventional combinations:	
Calcium (Ca)	993	$CaSO_4$	3,376
Magnesium (Mg)	254	$MgSO_4$	1,270
Sodium (Na)	8,108	K_2SO_4	174
Potassium (K)	165	Na_2SO_4	16,666
Sulphates (SO_4)	14,761	NaCl	6,317
Chlorides (Cl)	3,834	$NaHCO_3$	738
Bicarbonates (HCO_3)	536	$NaCO_3$	84
Carbonates (CO_3)	72		
Nitrates (NO_3)	Trace.	Total	28,625
Phosphates (PO_4)	Trace.		
Total solids	27,980		

Total solids determination made by evaporation and drying for five hours at 115°.

Analysis of a composite sample of alkali from the mesa slopes.

[Parts per 100,000.]

Constituent.	Quantity.	Constituent.	Quantity.
Ions:		Ions—Continued.	
Calcium (Ca)	45	Bicarbonates (HCO_3)	272
Magnesium (Mg)	35	Carbonates (CO_3)	0
Sodium (Na)	138	Nitrates (NO_3)	0
Potassium (K)		Phosphates (PO_4)	0
Sulphates (SO_4)	72		
Chlorides (Cl)	310	Total solids	872

Chlorides and bicarbonates predominate in the alkali on the mesa slopes, and sodium sulphate, sodium chloride, and bicarbonates in the accumulations in the valley. The chlorides present in all places in the area are second to black alkali in injury to plant growth. Owing to the porosity of the valley soils, however, and the ease with which the alkali salts are forced into the ground water, injury to plant growth from this source is less serious than where the soils are heavier in texture and where the alkali salts extend to greater depths in the subsoil material.

Reclamation of the alkali soils of this area can be accomplished more easily than in most arid regions. The subsoils are so por-

ous that ordinary irrigation will remove much of the alkali if the water table is lowered sufficiently to prevent it from reaching the surface by capillarity. One or two heavy irrigations would suffice to force most of the alkali down into the ground water, which would slowly remove it through the regular valley drainage. Any drainage system which will remove the ground water will also remove most of the alkali salts from the area.

In the valley most of the general farm crops thrive upon land containing 200 parts of alkali per 100,000 of dry soil, and in many instances good yields are obtained where the percentage is much greater. In places, however, where surface accumulations are heavy, it is necessary to irrigate and wash the salts into the subsoil or ground water before planting the crop. This enables the seeds to germinate and send their roots downward before sufficient quantities of injurious salts can return to the surface and cause damage. Many crops are grown in this manner in the area where the surface later becomes white with alkali.

The more resistant plants, such as sugar beets, sweet clover, oats, canaigre, sunflowers, tussock grass, salt grass, and European varieties of grapes, are quite tolerant of alkali. Apples, pears, and quinces can be grown on soils containing about 100 parts of white alkali per 100,000 of dry soil. Peaches, apricots, plums, rhubarb, mustard, kale, rape, clover, peas, and other very shallow rooted crops are sensitive to alkali and should be grown where there is least danger of its occurrence. Alfalfa and corn are quite sensitive to alkali when young, but when well established are able to produce good yields over most of the area, even where moderately high percentages of the salts occur.

SUMMARY.

The Middle Rio Grande Valley area is located slightly northwest of the center of New Mexico. It is 83 miles long and covers 274 square miles, or 175,360 acres. The area comprises a section of the recent valley of the Rio Grande, with a narrow margin of the slopes and uplands of adjoining mesas, or upland plains, along both sides of the valley. The general direction of the area is north and south. It has a fall southward of approximately 5½ feet to the mile. The average elevation is about 4,950 feet. The valley is thickly settled.

The population is predominantly Mexican, and outside of two or three of the larger cities and towns Spanish is the prevailing language spoken. Several Indian pueblos are located in the area, the most important of which are Isleta and San Felipe.

The area is well provided with good schools, telephones, and daily mail service. Albuquerque is the metropolis of the valley and is one of the most active business centers of the Southwest.

The climate is salubrious. The summers are moderately warm and the winters crisp, but not unpleasant. The average yearly rainfall is 7.2 inches, 47 per cent of which falls during the three summer months. Considerable high wind occurs during the spring months. There are over 200 days of sunshine each year. Diseases are infrequent.

The Santa Fe Railway and its branches traverse the valley, and no section of the area is more than 3½ miles from a railroad.

About one-third of the area is under cultivation. The farms are very small. The chief crops grown are alfalfa, wheat, oats, corn, asparagus, cabbage, truck, apples, pears, quinces, plums, cherries, grapes, some peaches, and apricots. Some dairying, hog raising, poultry raising, and bee culture are carried on. The growing of intensive crops offers excellent opportunities.

Water for irrigation is obtained from the Rio Grande, supplemented by pumping from an underground source on the highlands. About 50 independent community irrigation ditches supply water to the valley farm lands.

Considerable quantities of alkali occur over the valley floor, and the water table is very high at all times of the year, ranging from 6 inches to 6 feet from the surface, with an average depth of about 2 feet. Most of the alkali lands may be reclaimed by drainage with ordinary irrigation.

Labor is plentiful, but more or less unskilled.

Thirteen soil types, including Riverwash, were mapped. These soils range from medium sands to heavy clays. The heavy types are adapted to general farm crops, fruit, and dairying, and the lighter soils to truck and bush, vine, and early stone fruits. All of the types respond readily to applications of organic matter and good tillage and are productive under favorable conditions.

The soils of the area exclusive of Riverwash are classified under four soil series—the Tijeras, Anthony, Gila, and Brazito. The Tijeras and Brazito series are each represented in this area by but a single soil type.

The soil of the Tijeras series occurs upon the upland plains. The surface material consists predominantly of outwash alluvial and colluvial deposits derived from the Sandia Mountains and distributed over the underlying and older stream-laid deposits of the plains.

The soils of the Anthony series consist of colluvial and alluvial fan deposits marginal to the soils of the valley floor, and derived by erosion from the older alluvial deposits of the plains.

The soils of the Gila and Brazitos series are confined to the valley floor and river bottoms. The former consist of recent alluvial deposits of the Rio Grande and its tributaries. The Brazito series is

represented by a single type, consisting of wind-transported material derived from loose, unprotected alluvial material and deposited over portions of the valley floor.

The characteristics of the individual soil types may be briefly summarized as follows:

The Tijeras fine sandy loam is represented by only one small body occurring in the vicinity of the State University, east of Albuquerque. It occupies a small part of an extensive upland plain and is used for grazing, except where occupied by the university. It is an excellent soil, and if supplied with water is suited to a wide range of crops. Its greatest needs are irrigation, the addition of organic matter, and good tillage.

The Anthony sand is located along the mesa slopes. It is quite an extensive type, and when well supplied with organic matter and water produces good yields of early maturing truck, peaches, and cherries. It contains no alkali and is used for grazing.

The Anthony gravelly sand is the most extensive of the Anthony soils. It is a loose, incoherent, leachy soil, which is not suited to crops unless supplied with liberal quantities of organic matter and water. It is excessively drained and is free from alkali. It is not farmed to any extent at present, owing to the scarcity of water, but under irrigation it produces moderate yields of early maturing truck crops, cherries, and peaches. The type is in need of irrigation, humus, and good tillage.

The Anthony fine sand occurs in a few small, irregular bodies along the mesa slopes. When well tilled, irrigated, and supplied with liberal quantities of organic matter it is well adapted to truck, peaches, plums, cherries, bush and vine fruits, and alfalfa.

The Anthony fine sandy loam occurs in small bodies along the mesa slopes, and when well tilled, irrigated, and improved by the addition of humus it is well suited to a wide range of crops.

The Anthony silty clay loam occurs in a few well-defined bodies. It occupies the slopes of the uplands, and when irrigated ranks among the best soils of the area. Owing to its uniformity and good drainage it is well adapted to the growing of apples, pears, peaches, plums, cherries, quinces, bush and vine fruits, general farm crops, and truck. Irrigation and good tillage are its greatest needs.

The Gila sand is an inextensive type of little importance. Considerable leveling is usually necessary in preparing the type for irrigation. Where well drained the soil is moderately well suited to the crops suggested for the Brazito fine sand. Very little of the type is utilized for farming.

The Gila fine sandy loam is the most extensive type in the area. Most of this soil is low and poorly drained and affected with alkali. The low, wet areas are used for the production of wild hay and for

pastures. The better drained areas are well adapted to the same range of crops as the Gila loam. Drainage, the addition of organic matter, proper tillage, and the systematic rotation of crops are the most important factors in the cultivation of this type.

The Gila loam is one of the most extensive and perhaps the most important type of the Gila series. It is easily tilled, and where well drained and free from alkali will produce large yields of fruit, general farm crops, and truck. It is mainly in need of drainage, good tillage, and organic matter.

The Gila clay loam is an important type, and where well drained and free from alkali is adapted to heavy or late truck crops, general farm crops, and fruits. The water table is high and the soil contains alkali. The type is in need of drainage and organic matter.

The Gila clay occurs as low, flat bodies and is the most poorly drained type in the area. Where well drained it produces good yields of general farm crops and is well suited for dairy purposes. Drainage, good tillage, and humus are its greatest needs.

Riverwash, as mapped, includes the present river bed. It comprises extensive, flat areas of white sand exposed during low water in the river. It is subject to considerable modification by wind and flood waters and to overflow. Occasionally small areas are farmed to quickly maturing truck crops.

The Brazito fine sand is an inextensive type. Its surface is rolling and hummocky. The type is not used to any extent for crop production. Its preparation for irrigation is expensive, but it is generally free from alkali and responds readily to the addition of organic matter and to good tillage. Early maturing truck, cherries, and peaches are the crops best suited to this type.

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[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the Congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]

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U. S. DEPT OF AGRICULTURE
BUREAU OF SOILS
MILTON WHITNEY, CHIEF
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

SOIL MAP
NEW MEXICO
MIDDLE RIO GRANDE VALLEY SHEET

NEW MEXICO AGRICULTURAL EXPERIMENT STATION
LUTHER FOSTER, DIRECTOR. REX E. WILLARD, SOIL PHYSICIST.

SOIL PROFILE
(6 feet deep)

Tijeras fine sandy loam — Fsl / Cl / Fsl
Anthony sand — S
Anthony gravelly sand — Grs
Anthony fine sand — Fs
Anthony fine sandy loam — Fsl / Fs / L
Anthony silty clay loam — Sicl / Sic / Sicl
Gila sand — S / Mas
Gila fine sandy loam — Fsl / Mas
Gila loam — L / Mas
Gila clay loam — Cl / Mas
Gila clay — Mas / C
Brazito fine sand — Fs / Mas

LEGEND

Fsl Fine sandy loam
Cl Clay loam
S Sand
Grs Gravelly sand
Fs Fine sand
L Loam
Sicl Silty clay loam
Sic Silty clay
Mas Mixed alluvial sediments
C Clay

LEGEND

Tijeras fine sandy loam — Tf
Anthony sand — A
Anthony gravelly sand — Ag
Anthony fine sand — As
Anthony fine sandy loam — Af
Anthony silty clay loam — Al
Gila sand — Gs
Gila fine sandy loam — Gf
Gila loam — Gl
Gila clay loam — G
Gila clay — Gc
Brazito fine sand — B
Riverwash — R
Gravelly areas
Overflow areas
Alkali areas — A
Bluffs

Blue figures represent depth in inches to water table

Macy H. Lapham, Inspector in charge Western Division
Soils surveyed by J.W. Nelson L.C. Holmes and E.C. Eckmann,

Scale 1 inch = 1 mile
1 ½ 0 1 2 3 4 Miles

Field Operations
Bureau of Soils
1912